city, beyond which separate courses of destruction again appeared.

"Where the tornadoes finally disappeared is uncertain, but Lavonia, Ga., nearly 40 miles from Gainesville, experienced a tornado about an hour later, and Anderson, S. C., also had one on the same day. These places are nearly on a direct line east-northeast from Gainesville. However, reports of destruction at intervening points are lacking." See figure 2.

Probably the storm at Gainesville was the same one that was reported at Lavonia, Ga., about an hour later, and finally reached Anderson, S. C., nearly 70 miles northeast of Gainesville, at 10:05 a. m. If so, it traveled some 70 miles in approximately 90 minutes. Estimated damage at Lavonia was $10,000, but there was no loss of life. The width of the path at Anderson and vicinity was from 400 to 500 yards. Property damage was estimated at $250,000; about 50 homes were wrecked in the Anderson and Appleton Mill villages, and some houses in the Evans section destroyed. The tornado barely missed the business section of Anderson. Only one person was reported killed, but 30 were injured.

The group of tornadoes comprised in these two series, considering the number of people killed and injured, and the property damage, probably ranks third in destructiveness in the tornado history of the United States. In the first series of April 1–2, about 41 persons were killed and 540 injured; in the second, April 5–6, some 452 persons lost their lives and 1,775 were injured. In comparison there is a record of a series of tornadoes, supposed to have included some 60 separate storms, which occurred in several Southern States in February 1884 with an estimated loss of some 800 lives. Another outstanding tornadic disaster was the so-called "Tri-State" tornado of March 18, 1925, which occurred in the Middle West and caused more than 700 deaths, and in which some 3,000 persons were injured.

The paths of great tornadic destruction are so narrow and their occurrence so erratic that it is unusual for a locality, in the course of years, to be visited twice by such storms. However, this does happen occasionally. Two other tornadoes are known to have occurred in Gainesville, or vicinity, in past years. One of these was on March 25, 1884, destroying several houses and killing one or two persons. The other, on June 1, 1903, was much more destructive, with 98 people losing their lives; property damage was estimated at about a million dollars. In connection with the Gainesville storm, Mr. Mindling submits the following comments:

"The question has often been raised as to whether buildings of heavy, solid masonry and office buildings with strong steel framework may be expected to stand up under the full force of a violent tornado. The results at Gainesville give a good deal of assurance in favor of such structures. The city has a few such buildings, among which are the First National Bank, the Jackson Building, the post-office building, and the Baptist Church. These came through with only shattered windows and other minor damage, while less rigid structures around them were generally demolished. Even the more substantial brick buildings of recent construction crumbled around those named, of which only the church suffered much. It was partially unroofed and its interior damaged where wreckage fell in, but the heavy stone walls were not hurt.

"A very substantial stone monument 20 feet high and bearing a metal statute of a Confederate soldier came through unharmed on the Public Square at the very center of most appalling destruction. At the corner of Green and Washington Streets, just a few feet from the northernmost corner of the post-office building, a massive marble monument was broken to pieces and parts of the basal structure were carried away, including a block of granite about a foot thick and about 9 by 6 feet in length and breadth. This illustrates the violence of the wind that was brought to bear upon the post office and the Jackson Building next to it. The Baptist Church is just across the street from the wrecked monument."

THE NEWFOUNDLAND FOREST FIRE OF AUGUST 1935

By EARL B. SHAW

[State Teachers College, Worcester, Mass., February 1936]

August 13, 1935, was a day of misfortune for owners of timber land in north-central Newfoundland, and nearly brought tragedy to the town of Grand Falls. To the student of climate, the fire, which in a few days swept many square miles of forest, offers an interesting illustration of the importance of weather conditions for conflagrations. The writer, who was in Grand Falls during the middle of August, became greatly interested in the atmospheric relationships that were evident throughout the catastrophe. Personal observations and data furnished by residents of Grand Falls upon weather and daily progress of the fire, have made possible the following study of the relation of meteorological conditions to the start, expansion, and final extinction of the blaze.

Summer is the season of greatest fire danger in the timber-covered island of Newfoundland. At this period of the year, insolation not only removes the protecting blanket of winter snow, but also warms the air and lowers the relative humidity. The result is a dry forest bed and a dry atmosphere which make the fire hazard far greater than that of the cold season. The summer weather of 1935 increased inflammability in the forests even more than usual. Lower than average precipitation and relative humidity, and higher than average temperature and barometric pressure combined to produce exceptionally favorable conditions for fires.

Although the total precipitation for the first 7 months of the year was 3.88 inches [1] above normal (27.37 inches compared with a normal of 23.49 inches), the amount for June and July was 1.4 inches below normal (5.5 inches compared with a normal of 6.9 inches); and during the first part of August little more than a trace of rain fell. Moreover, the number of rainy days in June and July was the lowest on record, seven below normal.

[1] Official long time climatic data are exceedingly difficult to obtain in Newfoundland. Few official stations have a comprehensive record over a number of years. There is no Government weather observer in Grand Falls, but the statistics used in this article were furnished by a local firm that has kept careful records on certain climatic elements for 8 years. The writer checked these records with those which he procured from the Buchans Mining Co. at Buchans, a mining town approximately 50 miles to the southwest, and a close correlation was evident in most cases. The latter company has recorded weather data for a period of 5 years.

The following table indicates the extent to which summer temperatures of 1935 were above normal:

TABLE 1

	8 years	1935
Mean temperature:	°F.	°F.
June, July, and August	59.3	61
June	54.2	58.2
July	62.6	62
August	61.1	62.9
Mean maximum temperature:		
June, July, August	83.2	86
June	81.9	82
July	85.4	85
August	82.4	91

Students of forest fires consider high barometric pressures to be a contributing climatic element in fire weather; figures listed below show that the 1935 readings were markedly high:

TABLE 2

	8 years	Same period 1935
Mean barometric pressure:	*Inches*	*Inches*
First 8 months of year	29.67	29.77
June, July, and August	29.70	29.93
August	29.79	29.93
10-day fire period		29.99

The writer was unable to obtain any data on relative humidity for Grand Falls or for Buchans, except for the period of the fire, and these show only the minimum readings. However, 5-year records were obtained from Corner Brook, the other paper manufacturing town in Newfoundland. This station is situated near the west coast, a location giving it a higher relative humidity than that for the inland city of Grand Falls. Nevertheless as the trends of other climatic elements are similar between the two stations, the relative humidity should show some correlation. The figures for June and July 1935 in Corner Brook show a mean relative humidity of 2.3 percent below the 5-year normal.

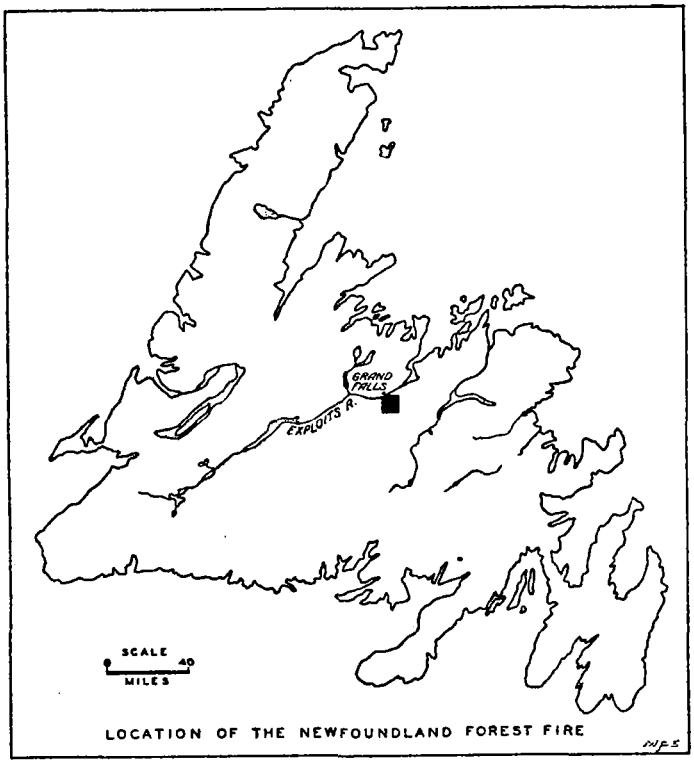

FIGURE 1. Location of the Newfoundland forest fire, August 1935. The fire started between the headwaters of two small streams, Stony Brook and Little Battling Brook, approximately 10 miles from Grand Falls.

High winds always favor the development of a forest fire. Although statistics were unobtainable except for the period of the fire, several residents of Grand Falls assured the writer that wind velocities during June, July, and the first part of August were above normal.

One may conclude from a study of the conditions during the period preceding the August fire, that critical meteorological elements were favorble for the blaze. Moreover, once the fire was started, a continued lack of rainfall, low relative humidity, high temperatures, and high winds all united to hinder control.

WEATHER CONDITIONS DURING THE FIRE

The fire was discovered near the headwaters of Stony Brook (figs. 1 and 2), approximately 10 miles south of Grand Falls, on the afternoon of August 13; immediately an organized attempt to stop it began, as a crew of 10 men, well equipped for fire fighting, started toward Stony Brook. These were reenforced by 10 more on the 14th; and on the morning of the 15th, control appeared possible. The wind had been light on the 13th and 14th, and had it remained light during the 15th, the fire undoubtedly would have been put out by those in charge—surely with the aid of the additional crew who early on the 15th were on their way from Grand Falls to the fire region; but instead, by 2 p. m. of the 15th, the wind velocity had increased to such a degree that all hope of limiting the fire, without the aid of a heavy downpour of rain, was lost.

A downpour did not come until the night of August 22, and in the meantime hundreds of men (newspaper reports indicate as many as 1,200 at one time) were sent to fight the fire. From the afternoon of the 15th until the 19th the fire crews were forced back in a general easterly direction before the prevailing westerly wind (fig. 2). On 3 of the 4 days, August 15 to 19, the wind was fresh; but in spite of the breeze the men gave way quite gradually and kept the blaze confined within less than one-fifth of the area which it gained so easily on the 20th when fanned by a strong wind from the west (fig. 2). On the 19th the direction shifted from west to east, velocity declined from fresh to light, and a slowly falling rain gave real hope of relief. These conditions were short lived. The total precipitation amounted to but 0.015 inch, and the morning of the 20th brought the strong westerly wind mentioned above. Moreover, the minimum relative humidity, which had averaged 40 percent for the previous 7 days (a relative humidity of 50 percent is considered dangerous in the timber regions along the northwest coast of the United States[2]) dropped to 28 percent (fig. 3), that afternoon. To complete the weather conditions favorable for the spread of a fire, the temperature rose to 91° F. In response to this ideal fire weather, the blaze expanded tremendously, with seven times the spread for any previous 24-hour period. The 20th of August 1935, will long be remembered at Grand Falls. Toward evening huge cumulus clouds arose over the fire area, only a few miles away.

By the 21st the strong wind had died down; and a light breeze from the south-southeast, with an increase in minimum relative humidity from 28 to 60 percent, made fire fighting less difficult than on the previous day.

[2] Dague, Charles I. Disastrous Fire Weather of September 1929, *Bulletin of the American Meteorological Society*, vol. XI, no. 12, December 1930, p. 215.

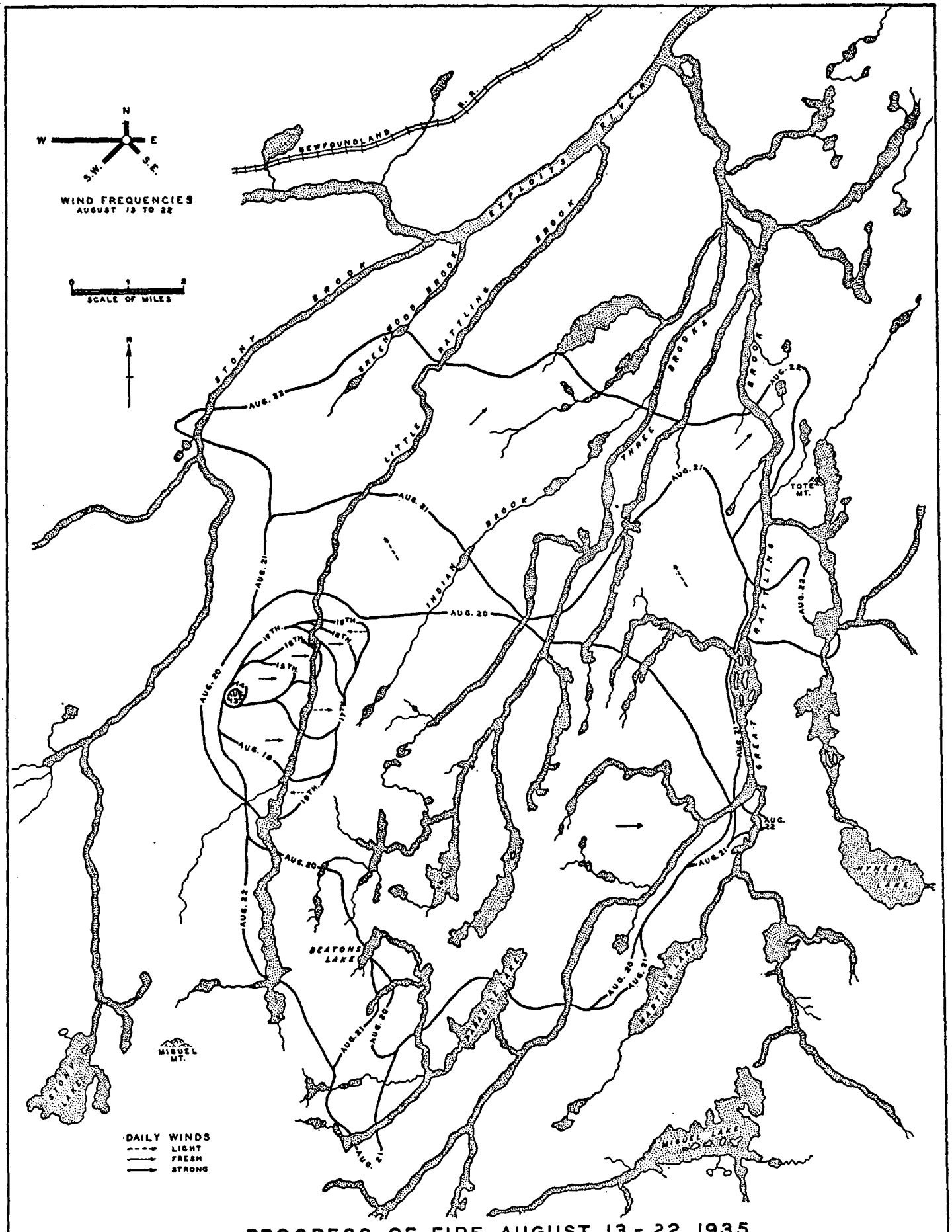
N
W
E
S.W.
S.E.
WIND FREQUENCIES
AUGUST 13 TO 22
0 1 2
SCALE OF MILES
NEWFOUNDLAND R.R.
EXPLOITS RIVER
STONY BROOK
GREENWOOD BROOK
RATTLING BROOK
LITTLE THREE BROOKS
INDIAN BROOK
GREAT RATTLING BROOK
AUG. 22
AUG. 21
AUG. 20
AUG. 19
AUG. 18
AUG. 17
AUG. 16
AUG. 15
TOTE MT.
BEATONS LAKE
PARADISE LAKE
MARTINS LAKE
HYNES LAKE
MIGUEL LAKE
MIGUEL MT.
DAILY WINDS
LIGHT
FRESH
STRONG
PROGRESS OF FIRE AUGUST 13 - 22, 1935.

FIGURE 2.

Nevertheless, there was a significant expansion to the north in two places, and the boundary nearest Grand Falls moved to within 4½ miles of that town. Arrangements were made for a special patrol during the night to guard against fire starting among the houses and the mill buildings, but the men went off duty early the next morning when a slight shift of the wind removed the danger from ash that had been blowing over the Falls.

Although the shift in wind direction on the 22d removed immediate danger from Grand Falls, an increased velocity and a decrease in relative humidity brought a corresponding increase in the difficulty of fire control in other sections, a problem so serious that the burned area was extended several miles northward over a wide front. About 5 p. m. however, the hundreds of fire fighters received reenforcements in the form of rain that helped more than all the equipment and men that had been fighting the flames for days.

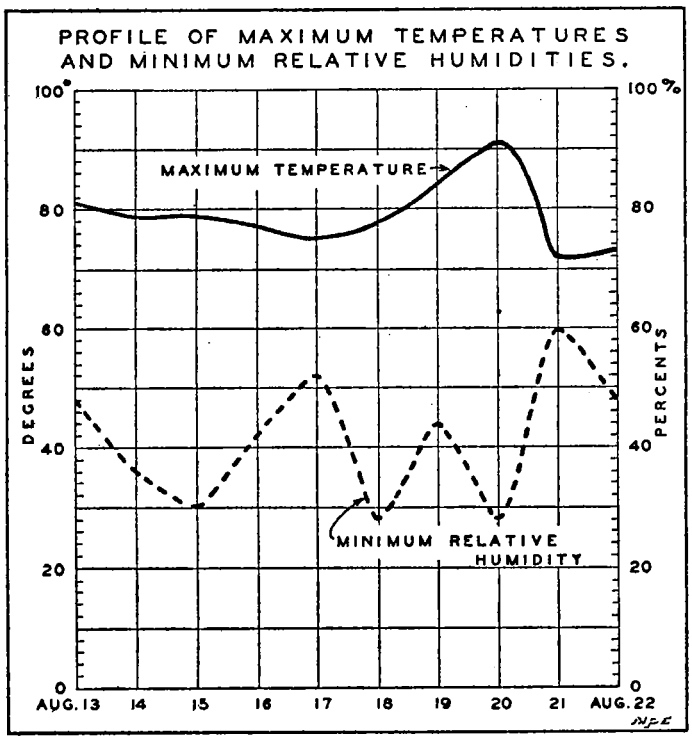

FIGURE 3.

WEATHER CONDITIONS WHICH EXTINGUISHED THE FIRE

On the evening of the 22d, a low pressure area moving in from the west (fig. 4) brought precipitation, lasting all night, which stopped the advance of the fire. With the passing of the LOW, a strong depression from the south brought increased rainfall; and before the rain was over, on Sunday the 25th, 5.08 inches of moisture had fallen, and all danger of further damage was eliminated.

The LOW from the south, which had started on August 18 as the first tropical storm in American waters in 1935, took a course slightly different from the average followed by most Caribbean hurricanes. A majority swing to the northeast soon after passing the latitude of the Florida Straits, and continue in that direction across the Atlantic. Had this LOW followed the normal path, the Newfoundland forest fire would have continued longer; but the general path of the August depression was north-northeast toward Newfoundland, the position of its center, Sunday, August 25.

While the storm favored Newfoundland by stopping the forest fire, it was decidedly unfavorable in several other respects. As the center of the LOW passed the Grand Banks, it caused heavy damage to fishing fleets and took a toll of lives estimated from press reports at upward of 50 in all, some as far north as the Labrador coast.

CONCLUSIONS AND SUMMARY

In considering the major elements which influenced the fire, several significant facts stand out: (1) Above-normal pressures, temperatures, and wind velocities, together with below-normal precipitation and relative humidity, during the early summer months of June and July greatly dried out the forest litter and increased its inflammability to such an extent that danger of fire was at a maximum; (2) From August 13 to August 22, inclusive, the prevailing wind direction was west on 5 days, southwest 2 days, east 1 day, south-southeast 1 day, and north 1 day. As a result of the general westerly direction of the wind, the fire spread a distance of approximately 10 miles in its greatest west-east advance, whereas with winds from the east on only 2 of the 10 days (actually, winds with an easterly component totalled but 43 hours) the greatest westward extension was approximately 1 mile. (3) On August 20 the fire spread over an area nearly as large as that of its progress during the other 9 days. A wind of great strength, a maximum temperature of 91° F, and a minimum relative humidity of 28 percent contributed greatly to this expansion. (4) Once well started, the fire could not be completely extinguished until a heavy rainfall was provided by two passing LOWS, one starting as a tropical hurricane. (5) The fire spread over a total area of approximately 100 square miles, 64,000 acres. Owing to the large number of lakes and streams in this glaciated land, only about 60 square miles, 38,400 acres, of actual timber were destroyed; hence the loss is hardly as great as it might appear from the first glance at the map. (6) The lakes and streams not only served as temporary barriers to the blaze, but also as places of refuge when the fire routed the fighters. More than one crew were forced to the water when other means of escape were cut off, and several lives were saved in this way. Although many men were incapacitated by smoke blindness and minor burns, not one of the thousand or more fighters lost his life as a result of the fire.

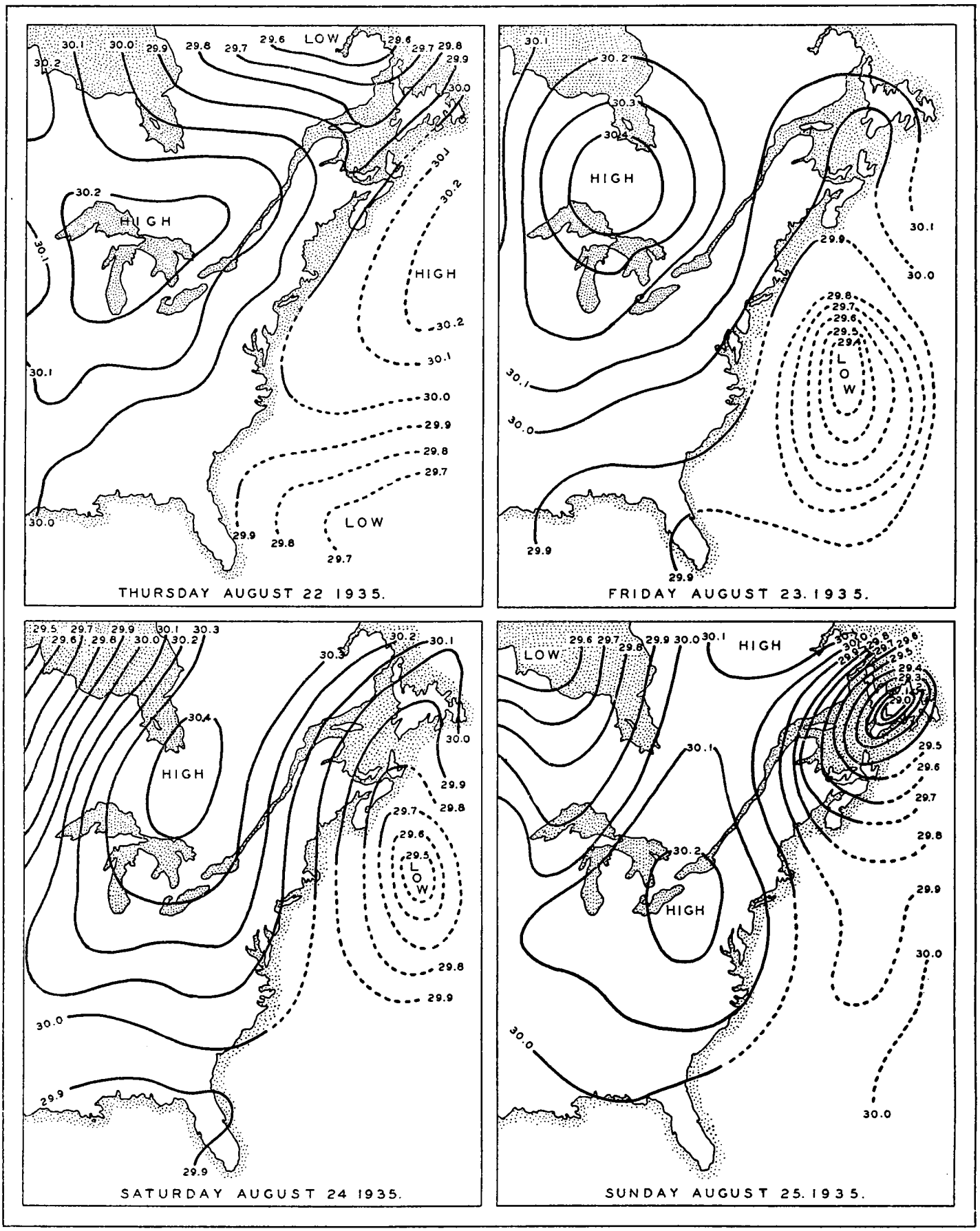

FIGURE 4. Movement of storms bringing rain to Newfoundland. On the 22d a low pressure area of medium intensity brought rain which started to drench the forest fire. The deluge which completed the task came with a storm that began its course as a tropical hurricane on the 18th of August. A complete chart of the storm movement and a detailed description of the depression may be found in the MONTHLY WEATHER REVIEW for August 1935.

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